Intertidal Habitat Projects Monitoring Program

Elliott Bay/Duwamish Restoration Program

Prepared for the
Elliott Bay/Duwamish Restoration Program Panel
by the
U.S. Fish and Wildlife Service, Western Washington Office

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March 2000

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Introduction and Overview

This report describes the monitoring approach for intertidal habitat restoration projects undertaken by the Elliott Bay/Duwamish Restoration Program (EB/DRP). These projects are being completed under the sponsorship and guidance of the EB/DRP Panel of Managers (Panel) in partial fulfillment of requirements of a 1991 consent decree. The express purpose of this monitoring program is to evaluate progress in achieving EB/DRP goals and objectives concerning habitat development and restoration projects. Monitoring costs were included in the budget of each project at the time it was proposed for approval due to the Panel's acknowledgment of the importance and necessity for project follow though.

The first section of this document provides a summary of the EB/DRP foundation, the approach to habitat development, and the purpose of the monitoring program. The second section presents physical and biological criteria for determining project success, associated monitoring tasks, and the rationale for their inclusion as they relate to EB/DRP objectives. The third section addresses program management and the budget for tasks defined in the monitoring program. An appendix to this report provides a brief description of the four intertidal habitat projects addressed by the monitoring program.

EB/DRP Foundation

Program Establishment and Structure

In 1990, a lawsuit was filed against the City of Seattle and the Municipality of Metropolitan Seattle (Metro) by the United States of America on behalf of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) under its authority as a natural resource trustee provided by the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). The lawsuit was filed to recover damages "for injury to, destruction of, and loss of natural resources resulting from releases of hazardous substances...into the environment in and around the Duwamish River and Elliott Bay, for the costs of restoring, replacing or acquiring the equivalent of the affected natural resources, and for the costs of assessing the damage to the affected natural resources" (U.S. vs. City of Seattle & Metro, 1991).

Rather than engage in lengthy and costly litigation, the City of Seattle and Metro, along with natural resource trustees, worked out a settlement agreement to establish a program to help restore and replace natural resources of Elliott Bay and the lower Duwamish River. The Consent Decree established a program for sediment remediation, source control, and habitat development, known as the Elliott Bay/Duwamish Restoration Program, or EB/DRP. Participating governments in the settlement include the United States, represented by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish and Wildlife Service (USFWS), the Department of Ecology on behalf of the State of Washington, and the Muckleshoot Indian Tribe and Suquamish Tribe in their roles as natural resource trustees in connection with treaty rights delineating usual and accustomed fishing areas. The natural resource trustees, together with the City of Seattle and Metro (now King County DNR) comprise the EB/DRP Panel of Managers (Panel). The Panel established two technical working groups to guide the sediment remediation and habitat development project selection process. Members of the Habitat Development Technical Working Group are listed under Acknowledgments at the beginning of this document.

Habitat Development Program Goals and Approach

Development of Habitat Goals

The Habitat Development Technical Working Group was established by the Panel to identify potential habitat projects, evaluate them against criteria that meet the goals of the Consent Decree and determine their feasibility. The working group also advises the Panel on "the acquisition of any right of access, lease, easement, fee title, or any other real property interest sufficient to permanently secure a site for any habitat development project..." (U.S. vs. City of Seattle & Metro, paragraph 30). A Concept Document (EB/DRP, 1994) developed by the working groups and the Panel outlines the program goals, objectives, and approach to project selection. The following specific goals were developed by the Habitat Development Technical Working Group and approved by the Panel:

> "Habitat development projects will be undertaken to benefit fish and wildlife species and the habitat attributes on which they depend. The overall goal of the Program will be a net gain of habitat function relative to current conditions in the Elliott Bay and Duwamish River estuarine system. It is recognized that the aquatic ecosystem of Elliott Bay and the Duwamish River estuary cannot be returned to a pristine condition, however, it is possible and desirable to provide increases in habitat quantity and quality. While a general objective of ecosystem recovery will be pursued, priority will be afforded projects or actions that benefit injured trust natural resources" (EB/DRP, 1994; p. 48).

In addition to the ecological goals and objectives identified in this document, the Panel recognizes that the long-term viability of the restoration projects relies at least in part in community understanding and acceptance of these restored natural features in the urban landscape. Accordingly, project designs include provisions for public access where this is consistent with site-specific requirements. Also, and consistent and appropriate with the specific project's primary purposes, the project designs accommodate the related objective of providing educational displays and opportunities.

Habitat Development Approach

Property Acquisition and Protection

In seeking to meet EB/DRP habitat restoration objectives, the first step has been obtaining "real property interest" in sites for restoration work. The Consent Decree establishes a responsibility on the part of the City of Seattle and King County to provide up to $5 million in property value for this purpose. Following a ranking of potential restoration sites by the Habitat Development Technical Work Group, project sites were then selected. The Panel requested either King County or the City of Seattle to engage in negotiations for either acquisition of real property or easements in perpetuity for priority sites. At the conclusion of successful negotiations, the Panel credited King County or the City the cost of property or easement acquisition, toward fulfillment of the real property obligation of up to $2.5 million each.

To date, the following sites have been acquired:

- Seaboard Lumber site, acquired in fee title from a private owner by Seattle Parks and Recreation. Approximately 5 acres of formerly industrial uplands, and nearly 10 acres of adjacent submerged lands were acquired. The City has requested credit of $2.5 million in fulfillment of its real property obligation under the

Consent Decree. This amount includes nearly $1.5 million in funds set aside to complete soil contaminant remediation activities necessary to make the site available for habitat development.

- Hamm Creek site, made available by permanent conservation easement to King County by Seattle City Light. The County received a credit of $750,000 for the purchase of an easement on approximately 7.1 acres of upland, for the purposes of restoring Hamm Creek to a surface water channel, and creating a new "estuary" at the mouth of Hamm Creek where it enters the Duwamish River.

- Kenco Marine, purchased from a private owner by the Muckleshoot Indian Tribe. This site includes 0.7 acres of upland, and an undetermined amount of adjacent tidelands. The tribe purchased this former marine salvage operations site with funds from King County, and $518,000 from EB/DRP.

- North Wind's Weir, owned by King County Parks and Recreation. Approximately one acre of a three acre parcel is being made available to EB/DRP for intertidal habitat restoration, at a cost to the program of $416,000.

(See Appendix A for a more complete description and site plans of EB/DRP intertidal habitat projects)

In addition to these habitat development sites in the lower Duwamish River, EB/DRP has committed up to $700,000 for two sites upstream of this area in the Green River including Porter Levee and Lones Levee. At these sites, various riparian and off channel habitat restoration will occur with non-EB/DRP funds.

Finally, a nearshore substrate enhancement project was completed with EB/DRP support in the marine environment of Elliott Bay. This project occurred on property managed by the Washington Department of Natural Resources; EB/DRP incurred no property acquisition costs for this project. These projects are outside the scope of the intertidal habitat monitoring program described in this report.

Restoring Habitat Functions

Restoring the conditions necessary to provide habitat for fish and wildlife in an urban industrial environment often requires a combination of actions once a site has been made available. Habitat project restoration activities undertaken by the Panel in the lower Duwamish River entail one or a combination of the following actions: remediation and cleanup; source control; fill removal, excavation and regrading; stream daylighting; substrate modification; revegetation; and project follow-through. Monitoring tasks and contingency measures address these actions as required by specific projects. The following is meant as a general description of actions, some or all of which are being applied at each of the four Duwamish River estuary habitat development sites.

Remediation and Cleanup

Project sites selected for habitat development activities have a varied land use history. At Seaboard Lumber, industrial activities have contributed to soil contamination which requires remediation prior to habitat development. This has included both removal and isolation of site contaminants. At North Wind's Weir and Kenco Marine, required cleanup activities involve demolition and removal of previous residential and commercial infrastructure.

Fill Removal, Excavation, and Regrading

All four intertidal habitat project sites require the removal of historic fill material and regrading to reestablish intertidal elevations. At Seaboard, North Wind's Weir and Hamm Creek,"basins" are being created to restore intertidal habitat area. At the Kenco Marine site, benches or terraces are being excavated to create suitable elevations for mudflat, marsh, and riparian habitat development.

Stream Daylighting

Hamm Creek currently discharges into a storm drain system and flows underground before it discharges to the Duwamish River. The project at Hamm Creek involves "daylighting" this stream by creating a new surface water channel and mouth. The new channel will include various log and rock features to provide habitat structure and complexity. The new mouth will provide intertidal habitat where the stream meets the Duwamish River.

Substrate Modification

Prior to reestablishing riparian and emergent marsh vegetation, the project sites have required varying degrees of substrate modification. This ranges from simply amending existing upland soils with organic material to promote riparian vegetation growth, to a substantial import of soil at the Seaboard Lumber site for emergent marsh area establishment.

Revegetation

All projects involve efforts to promote native plant community establishment, including riparian areas with trees and shrubs and intertidal emergent marsh areas. Tasks necessary to promote initial plant growth, may include the installation of irrigation systems in riparian areas, and the protection of newly established plants from herbivores, especially Canada geese.

Project Follow-through

The EB/DRP Panel has recognized that habitat development does not end with project construction. Meeting program goals will necessitate follow-through activities, including site stewardship, monitoring, and implementation of contingency measures.

Intertidal Habitat Projects Monitoring Program

Development of the Monitoring Program

The monitoring program was developed by USFWS for EB/DRP, with input and assistance from the Habitat Development Technical Working Group (HDTWG). Assistance in monitoring program review was also sought from those with regional expertise in habitat restoration and monitoring. A draft was presented to the Technical Working Group after the real property acquisition phase and habitat project selection process had been largely concluded.

With the exception of the Elliott Bay Nearshore subtidal habitat development project, this monitoring program will be implemented for all EB/DRP funded habitat development projects, as follows:

- Seaboard Lumber - project management provided by Seattle Department of Parks and Recreation

- Hamm Creek Estuary - project management provided by King County DNR in cooperation with the U.S. Army Corps of Engineers

- (former)Kenco Marine site at Turning Basin Number 3 - project management provided by the Muckleshoot Indian Tribe Fisheries Department

- North Wind's Weir - project management provided by King County Parks Department in cooperation with King County DNR

Purposes of Monitoring Program

The monitoring program serves the necessary purposes of the Panel by identifying explicit project objectives against which project performance can be measured; providing criteria which indicate success in meeting those objectives, and delineating specific tasks to be completed to assess project performance. The monitoring program also identifies some of the potential problems that can reasonably be anticipated and contingency measures that could be taken in response. The program is intended to meet applicable requirements under the Clean Water Act (§404), any permit conditions under WDFW's Hydraulic Project Approval (HPA), and other environmental compliance activities.

This document also serves as an outreach tool by providing program and budget information to interested parties, including local stakeholders, schools, and consultants and others in the private sector. It is anticipated that activities undertaken pursuant to this monitoring program will contribute to the growing body of knowledge concerning restoration programs. The monitoring program budget provides a useful tool to others interested in estimating habitat restoration project monitoring costs.

Finally, the Panel recognizes the inherent scientific interest in these projects and activities. Hence, landowners of habitat project sites are encouraged to accommodate scientific research activities where the Panel determines that the activities are compatible with the objectives of specific habitat project(s). Research activities that are beyond the scope of this monitoring program and independently supported are encouraged. Towards this end, the Panel will make available all monitoring program data.

Project Success Criteria, Monitoring Tasks, and Contingency Measures

The following chapter identifies the specific criteria which will be used to determine if project goals for restoring intertidal habitat functions have been met. Criteria are broadly grouped into categories of "physical" and "biological" success criteria. For each criterion, quantifiable performance measures are detailed, the sites and monitoring years to which the criterion apply identified, and the general approach to evaluating the criteria described. Rationale for including the criterion and a relationship to habitat goals are discussed at the end of each subsection. Table One, located at the end of this chapter, provides a summary of the five physical criteria and eight biological criteria.

Physical Success Criteria

The first challenge to be met in restoring intertidal habitat functions involves the establishment of physical conditions necessary for habitat development. The following success criteria provide guidance in determining whether post-construction site characteristics meet these necessary requirements. Evaluating project performance against each of these is intended to be an on-going process that will continue until the tenth year following project construction. Assuming project construction is completed in mid to late 2000, project monitoring would begin in 2001, with the final year of project monitoring taking place in 2010. Monitoring project reports which summarize results would be completed in each of the years of major sampling activities; this would include post-construction years 1, 2, 3, 5, 7, and 10.

Intertidal Area

Physical Success Criterion 1

The total restored area between an elevation of +12.0 ft. MLLW and -2.0 ft. MLLW will be at least 90% of the target intertidal elevation for each site.

Project Sites

2.0 acres for Seaboard Lumber and no moorage of vessels within the property boundaries of the site

1.0 acres for Hamm Creek estuary

0.3 acres for Kenco Marine/Turning Basin vicinity and no moorage of vessels within the property boundaries of the site

1.0 acres for North Wind's Weir

(note – moorage restrictions apply to those sites where interest in subtidal "submerged land" was obtained along with the upland area)

Monitoring Task

Using standard areal calculation techniques, such as geo-referenced aerial photogrametry, GPS or other field survey techniques, estimate the total acreage of the project that is intertidal, i.e. below an elevation of +12.0 ft. MLLW.

In addition to tasks identified for completion as part of this monitoring program, it is

anticipated that the entities implementing each of the projects will provide as-built surveys upon completion of construction activities. This will assist in further quantifying project area and features, as well as serve to verify that projects were constructed as designed (compliance monitoring).

Years
This task is to be completed in post-construction years 1, 2, 3, 5, 7, and 10.

Contingency Measures
None, unless gross deviations from the criterion are determined to warrant corrective measures by the EB/DRP Panel of Managers. A gross deviation is considered to have occurred if the reduction in area has compromised the desired functions of the site.

Discussion
The ultimate goal of the EB/DRP habitat development program is improvement in the quality of habitat conditions for the benefit of fish and wildlife. Quantity is especially important in an area like the Duwamish River estuary, where the amount of intertidal habitat is severely limited. Certain minimum expectations for project size are legitimate success criteria. If some habitat elements are too small, they will provide little benefit and will not be able to maintain themselves. It is, however, necessary to recognize that this is not a perfect science, and that some variation in the amount of intertidal area is to be expected. Therefore, this criterion is stated as a range of acceptable values. It is also recognized that one of the benefits of the Kenco Marine/Turning Basin vicinity project was removal of barges and vessels moored over intertidal land at and adjacent to the site. A similar benefit associated with the Seaboard Lumber site was the purchase of adjacent submerged lands that preempts moorage of barges or vessels over this portion of the site. While these adjacent areas are not included in the calculation of restored intertidal area, the benefits of these intertidal or submerged lands will be considered during the evaluation of whether the sites meet this criterion.

Tidal Regime

Physical Success Criterion 2
Tidal amplitude, as determined by both timing and elevation of high and low tide events, is equivalent inside and outside of the project area.

Project Sites
This criterion and associated task are to be applied to Seaboard Lumber, Hamm Creek estuary, and North Wind's Weir habitat project sites. The criterion will not be applied to the Kenco Marine/Turning Basin Vicinity project because this site will always have adequate tidal connection because it is along the river channel.

Monitoring Task
Tide gauges (water surface elevation vs. time) will be installed in projects with a semi-enclosed basin. Data from the gauges will be compared to that from similar instruments deployed outside the project area within the Duwamish River estuary.

Years
This task is to be completed in post-construction years 1, 2, and 5.

Contingency Measures
Failure to meet this criterion should trigger discussions on the need to increase the size of

the tidal connection between the project area and the river.

Discussion
The development of adequate tidal connections between the project sites and the Duwamish River estuary is essential. Inadequate connection would lead to a dampened tidal hydrology, which may in turn favor the establishment of invasive plant species over desired native plant communities. Other possible consequences include reduction in fish access to and use of the sites, reduced export of organic material from the site and associated food web support for the estuary, and excessive current velocities within the channels and openings that provide the connection, and associated problems with erosion.

Slope Erosion

Physical Success Criterion 3
No evidence of erosion that threatens property, infrastructure, or is otherwise unacceptable is observed after a period of initial site stabilization.

Project Sites
This criterion will apply to all sites.

Monitoring Task
Periodic visual inspections of the project area for signs of excessive erosion will be completed. Areas of concern will be photographed from a stable photo point periodically so that the rate and severity of erosion can be judged. Where available, "as-built" site surveys will be used to monitor changes in site geomorphology, especially where these surveys are repeated on a periodic basis. Cross section elevation data collected across permanent transects though the project sites will provide another way of evaluating how the site morphology is changing.

In addition to visual inspection tasks specific to this criterion, analysis of aerial photos and elevation cross section survey data to be obtained under Physical Criterion #1 tasks will assist in quantifying the extent of erosion at the project sites.

Years
This criterion will be applied in years 1 through 10.

Contingency Measures
The first line of defense against excessive erosion should be non-structural approaches, such as vegetation, fiber mats, or other "soft" approaches. Engineered approaches such as riprap or other shoreline "hardening" (e.g. logs, rootwads) should only be utilized as a last resort, and in cases where the property owner, EP/DRP Panel, and relevant permitting authorities agree that a hazardous condition to property exists or the need to preserve function and integrity of the site that warrants corrective action.

Discussion
Given the urban setting of these projects, a balance must be struck between allowing the sites to develop naturally, and protecting the interests of property owners. Furthermore, soil disturbance during construction will leave many of the sites vulnerable to erosion until the planted vegetation matures and the root mat binds and stabilizes the soil. Concern about erosion has been raised, and the need to evaluate the "stability" of newly graded slopes generally agreed to by the EB/DRP Panel. It is difficult to express an entirely objective criterion for this factor; the one proposed will require a fair amount of

interpretation by the EB/DRP Panel and the affected land management entity.

At the Seaboard Lumber site, evidence of erosion at areas containing residual soil contamination would trigger sediment sampling nearby. This contingency measure would be a condition of Washington Department of Ecology's approval of cleanup at the site.

Sediment Structure

Physical Success Criterion 4

Over time, sites will accumulate fine grained material and organic matter. This would be evidenced by a decrease in mean grain size, and an increase in organic carbon, in surface sediments.

Project Sites

This criterion will be applied to all sites.

Monitoring Task

Sediment grain size samples will be collected at each site in areas that will also be sampled for benthic invertebrates. Where appropriate, consideration will be given to stratifying the project sites into two sampling areas, vegetated (+10 MLLW ft. and above) and unvegetated (+9 ft. MLLW and below) and a total of 6 samples collected (3 samples @ 2 elevations). Samples will be taken by the use of cores. Cores will be processed for grain size distribution in the laboratory using nested sieves. Organic content will be analyzed using standard procedures. Samples will be taken from habitat reference sites within both the Turning Basin and Kellogg Island areas and similarly processed.

Data will be reported as a percent of grain size category (by weight). Percent organic matter will be reported as a proportion of the overall sample. These values will be compared to reference site data, and to comparable data from the same site in previous years (time series).

Years

The monitoring task is to be completed in all years where benthic invertebrates are sampled; the recommended frequency is years 1, 2, 3, 5, 7, and 10.

Contingency Measures

None.

Discussion

Several intertidal habitat functions are associated with depositional environments. Specifically, the accumulation of fine grained sediment is indicative of environments that support the build up of organic matter and a detritus based food web. Soft sediments and organic rich areas provide an environment where benthic invertebrate prey resources flourish, and the capacity for fish and wildlife to forage. Of special interest to EB/DRP is the provision of habitat for juvenile salmonids, other estuarine fish, and shorebirds.

Sediment Quality

Physical Success Criterion 5

No evidence of contamination due to sediment transport or on-site migration of upland contaminants to groundwater or aquatic area.

Project Sites

This criterion will be applied primarily to Seaboard Lumber and to other projects only as needed.

Monitoring Task
Visual monitoring to ensure that riprap and soil are staying in place, and groundwater monitoring to ensure that contaminants have not mobilized due to construction. Groundwater monitoring is not included as a task in this monitoring program, but is a separate responsibility of the landowner (Seattle Parks and Recreation Department) related to site remediation activities that preceded habitat development.

Years
This criterion should be applied in years 1-10.

Contingency Measures
If monitoring results indicate that contaminants may be migrating at the Seaboard Lumber site, sediment monitoring will be required.

Discussion
Sediments at project sites may become contaminated due to pollution sources and sediment transport from off-site. Sediment monitoring will occur only as a contingency measure to determine cause if selected biological success criteria are not being met. Biological success criterion 8, production of benthic invertebrate prey taxa, is expected to be the most sensitive to sediment contamination.

Based on sampling activities and analyses undertaken prior to purchase of the property for habitat purposes, the Washington State Department of Ecology did not require cleanup of aquatic sediments under the state Sediment Management Standards at the Seaboard project site. However, visual and groundwater monitoring is required by the Department of Ecology as a condition of its approval of the upland cleanup to ensure that upland contamination does not migrate into the aquatic system.

The Panel considered whether sediment sampling should be included in this monitoring program, particularly for the Seaboard Lumber site upland areas, which were contaminated during the time the site was used as a lumber mill and for wood treatment. As part of the habitat restoration, soils contaminated with mercury, pentachlorophenol and polycyclic aromatic hydrocarbons (PAHs) were excavated and disposed of at an authorized sanitary landfill. Some petroleum contaminated soils were also removed, but it was not feasible to remove some additional low-level petroleum contaminated soils which occur at depths below the groundwater table. The areas of residual petroleum contamination on the upland were capped with clean soil and stabilized with riprap filled with fish rock. Groundwater has tested clean, indicating that the petroleum is currently non-mobile.

Biological Success Criteria

Biological success criteria identified in this monitoring program generally fall into one of two broad categories. First, there are those criteria that provide evidence that "attributes" of functioning intertidal habitat are developing within the project area (see Simenstad et al., 1991, for a discussion of this concept). For example, are the prey resources, essential to the function of foraging by juvenile chinook salmon, present in sufficient numbers to indicate the habitat is functioning properly? Second, there are criteria that directly

evaluate fish and wildlife presence within the project area. While it may seem that this second set of criteria is sufficient to determine the success of the project, this is not always the case. Presence or absence of a target species fails to quantify the value of the habitat for the species. Failure to observe the target species within the project area does not always mean that it has not, or will not in the future, use the area. Finally, it could be argued that it is not the responsibility of a project proponent to insure use of a habitat site, only to provide the conditions necessary to support that use.

The approach taken in this monitoring program relies primarily on an evaluation of habitat attributes such as vegetation and prey resources to evaluate project success. However, this data will be supplemented with some direct measurement of target species, including juvenile salmonids and other estuarine fish, as well as bird use of the restoration sites.

Marsh Vegetation Establishment

Biological Success Criterion 1

The areal extent (percent cover) of vegetation should be stable or increasing within portions of the project site with elevations suitable to marsh establishment.

Biological Success Criterion 2

Species composition of native wetland plant species should be comparable to that of appropriate reference sites, and should not contain greater than 1% cover by area by non-native or invasive plant species. Invasive plant species of special concern include *Spartina* spp. (cordgrass), *Lythrum salicaria* (purple loosestrife), *Phalaris arundinacea* (reed canarygrass), and *Phragmities communis* (common reed).

Biological Success Criterion 3

Plant vigor, as measured by stem height and shoot density, should be comparable (greater than 80%) to that of appropriate reference sites and/or improving over time.

Project Sites

These criteria will be applied to all sites.

Monitoring Tasks

Areal Extent

Areal extent of vegetation will be measured from aerial photographs, if available. Alternatively, given the anticipated size of vegetation patches, it is feasible to use either GPS or more traditional survey techniques to map the patch perimeter.

Species Composition and Plant Vigor

Based on consultation with a biostatistician, several permanent transects will be established at each project site perpendicular to the shoreline. The transects will encompass portions of the project area suitable for intertidal vegetation establishment. Transects will also be established within suitable reference sites near the project site. During mid-summer, the transects will be surveyed to determine species composition. Ten (or more, depending on length of transect) 0.25 x 0.25 m quadrats will be randomly distributed along each transect line. All plant species observed within the quadrat will be recorded, and percent cover of species within the transect estimated. Permanent transects will be periodically surveyed, to determine elevation ranges for vegetation communities at project sites.

Plant vigor will be assessed during the same sampling event using these quadrats. In each

quadrat, the total number shoots of the "target" vegetation species (e.g. *Carex lyngbei*, *Scirpus validus*) will be counted. The height of the three tallest shoots for each represented target species will also be measured to the nearest cm.

Data analysis will include an estimate of areal extent of marsh vegetation cover, and any observations in changes over time. Similarly, trends in mean shoot density (# shoots/ m^2) and mean maximum shoot height will be reported. Finally, species composition of marsh vegetation, and any occurrence of invasive species that exceeds 1% will be reported.

Years
The monitoring tasks are to be completed in years 1, 2, 3, 5, 7, and 10.

Contingency Measures
Any occurrence of invasive species that exceeds the threshold established in Criterion 2 will be met with an immediate response of control measures. Physical removal will be undertaken prior to consideration of the use herbicide.

Evidence that planted vegetation is not thriving, or that natural recruitment rates fail to meet expectations of will trigger consideration of contingency measures. Depending on the hypothesized reason for this failure to meet the criteria, responses could include additional planting, soil amendments, herbivore exclusion, and/or focused stewardship efforts. The efficacy of structures intended to limit Canada goose herbivory will be evaluated. Assumptions about appropriate plant species, elevations, and other design factors should be reexamined.

Discussion
An important objective of all EB/DRP intertidal habitat projects is the establishment of marsh vegetation. Vegetation provides habitat structure, facilitates sediment accretion and build up of the marsh substrate, and serves as a source of organic material to support detritus-based food webs. Periodic examination of the vegetation will assist in the identification of potential problems, such as colonization by invasive plant species, excessive herbivory, or trampling by humans. Useful measures of vegetation community condition include plant distribution, species composition, and plant vigor.

Riparian Vegetation Establishment

Biological Success Criterion 4
Areal extent of riparian vegetation (native trees and shrubs) should be stable or increasing over time, and cover not less than 90% of the upland vegetated area of each project site at the end of ten years. Invasive plant coverage should be minimal; species of special concern include *Rubus procerus* (Himalayan blackberry), *Cytisus scoparius* (Scot's broom), and *Polygonum cuspidatum* (Japanese knotweed). Percent coverage of vegetation layers should be as shown in the following table:

Vegetation Layer	Year 3 coverage	Year 5 coverage	Year 10 coverage
herb	>70%	percentage may decline as other layers mature, provided not more than 10% bare ground	
shrub	>30%	>50%	>80%
tree	>25%	>40%	>70%
non-native vegetation	<10%	20%	<20%

Biological Success Criterion 5
Survival of riparian plantings in each cover class category (herb, shrub, trees) should be at least 75% at the end of three years.

Project Sites
These criteria will be applied to all sites.

Monitoring Task
Using aerial photograph analysis or standard survey techniques, map the portion of the project area with riparian vegetation cover.

Extend vegetation transects established for marsh vegetation monitoring shoreward, through the riparian zone, to the limits of the project area. Use visual survey techniques such as point line intercept or quadrats to estimate planting survival along the transect line.

Years
The first monitoring task (areal extent) is to be completed in years 1, 2, 3, 5, 7, and 10. The second monitoring task (plant survival) is to be completed in years 1, 2, and 3.

Data should be reported as percent cover of riparian vegetation, and percent survival of plantings broken down into the herb, shrub, and tree components.

Contingency Measures
Excessive failure rates for planting survival will be addressed with contingency measures. Potential causes may include improper installation, poor soil structure and/or organic content, inadequate watering, herbivory, trampling or competition. Improved site stewardship may address many of these problems, but replanting with improved soil preparation may also be necessary. While the criteria should be used in evaluating project performance, it is also important to recognize the need for some flexibility in managing the project sites. Failure to meet numeric criteria should not trigger an automatic response that might prove damaging to the project.

Inadequate riparian vegetation coverage may also be attributed to the same causes. Appropriate response may include additional plantings, soil amendments, and/or improved stewardship.

Discussion
The establishment of healthy riparian plant communities at each habitat site is an essential project element. Native trees and shrubs provide a buffer to adjacent urban and industrial land uses and habitat structure for wildlife. Insects growing on riparian vegetation that are deposited in the water can provide an important prey resource for fish. Leaf litter enhances detritus food webs when transported into adjacent intertidal areas. Large organic debris is also important for habitat structure.

Bird Use

Biological Success Criterion 6
Use of the restoration sites and the area within 50 meters of the site by indigenous/native bird species should be comparable of that to appropriate reference sites.

Project Sites
This criterion will be applied to all sites.

Monitoring Task
Using the protocols and categories (ie. passerine, raptors, shorebirds/waders, waterfowl, seabirds, introduced, and native but human associated) described by Cordell et al. (1999), describe bird use of the restored sites and appropriate reference areas. Data will be presented as species observed, mean abundance (by category), and species richness of indigenous/native bird species.

Years
The monitoring tasks are to be completed in years 1, 2, 3, 5, 7, and 10.

Contingency Measures
Low bird use of restored sites, relative to reference areas, may indicate human disturbance. If data indicates that indigenous/native bird species are absent, or present infrequently or in low numbers, public access and other management activities at the site should be examined for potential impacts to wildlife.

Discussion
Use of the sites by birds would be a good indication of improved habitat conditions. Previous monitoring studies of Duwamish River restoration sites have loosely grouped seasonal and resident birds into guilds, as well as categorized introduced and native, but human-associated species separately (Cordell et al. 1994, 1996, 1997, 1999). These distinctions have been useful in evaluating the wildlife habitat function of the sites.

Fish Access/Presence

Biological Success Criterion 7
Estuarine fish will access the project sites. Juvenile salmonid presence within the project sites should be comparable to that of appropriate reference sites at the end of ten years.

Project Sites
This criterion will be applied to all four project sites.

Monitoring Tasks
Consistent with the protocols described by Cordell et al. (1997, 1999) for the T-105 restoration site, fish access at Seaboard Lumber, Hamm Creek estuary, and North Wind's weir will be monitored by use of fyke net or block seine. At high tide, a net which

completely blocks the mouth of the project area will be deployed, and monitored during the subsequent ebb. At the Kenco Marine/Turning Basin vicinity site where use of a fyke net or block seine is not practical, a beach seine shall be used at high tide using the protocols describe in Warner and Fritz (1995). At all sites, captured fish will be briefly anesthetized, identified to species and counted. Fork length measurements will be taken from all salmonids. All fish will be released unharmed, unless stomach content analysis on a subset of captured fish is determined necessary by USFWS. Consideration will be given to marking a subset of the captured salmonids to determine residence time.

Given the importance placed on juvenile salmonids, the sampling will occur on a twice monthly basis during the period of juvenile out-migration, i.e. from early March through early June. If resources permit, consideration should be given to undertaking fish access monitoring for a longer period, perhaps throughout the year.

Years
The monitoring tasks are to be completed in years 1, 2, 3, 5, 7, and 10.

Contingency Measures
Failure to meet fish access criteria would indicate that fundamental EB/DRP goals are not being met. While the specific causes are difficult to project at this point, an examination of the project design, implementation, and site management would be warranted. Outside expert assistance may be obtained in evaluating the monitoring data and project performance.

Discussion
An issue of significant importance to EB/DRP is the provision of habitat to support estuarine-dependent fish species. Of special interest are juvenile salmonids, which are known to utilize these areas (Aitkin, 1998), and which may be limited in part by lack of high quality intertidal habitat in the Duwamish River estuary. Evaluation of this program goal will rely upon measuring both fish access to the restored sites, and the provision of prey resources, including fallout insects and benthic invertebrates important to juvenile salmonids.

Invertebrate Prey Resource Production

Biological Success Criterion 8
Production of invertebrate prey taxa known to be important to juvenile salmonids should be comparable to that of appropriate reference sites at the end of ten years.

Project Sites
This criterion will be applied to all four project sites.

Monitoring Tasks
Sampling protocols for fallout insects (insects produced on riparian and marsh vegetation that fall or drift into the water column) and benthic invertebrate are well described by Cordell et al. (1994, 1999) and have been extensively applied and refined at other Duwamish River restoration sites. To summarize, fallout insects are sampled by use of floating plastic bins distributed throughout a project site. Benthic invertebrates are best sampled with cores taken to a depth of 10 cm. Cordell recommends a minimum of 10 replicates in each "stratum"; strata include mud or sand flats and areas of marsh vegetation. Taxa known to be important to juvenile salmonids are identified to species

and enumerated, the remainder are identified to order level.

In addition to evaluating prey resource productivity of the intertidal habitat restoration projects, this task will also be used to screen for sediment contamination. The overall productivity of the sites, as well as a community level analysis will be used to determine whether there is indication of sediment contamination that warrants more detailed site investigation. The composition of the benthic organism community will be analyzed to determine if pollution tolerant species are present in abundance.

Contingency Measures
Failure to invertebrate prey taxa criteria would indicate that fundamental EB/DRP goals are not being met. While the specific causes are difficult to project at this point, an examination of the project design, implementation, and site management would be warranted. Outside expert assistance may be obtained in evaluating the monitoring data and project performance. If the benthic community does not appear to be healthy, sediment quality sampling may be initiated to determine if contamination is responsible for the problem. Lack of a productive benthic community could indicate inadequate physical conditions on site, such as unsuitable sediment grain size or excessive wave energy and scouring. Lack of fallout insects could indicate problems associated with riparian or marsh vegetation.

Discussion
See discussion under "Fish Access/Presence".

Benthic organisms, in constant contact with the sediments at the restoration sites, may provide an indication of sediment contamination. Because sediment chemistry analysis been determined to be unwarranted by the Panel, analysis of the benthic community provides a surrogate and trigger for more detailed studies of sediment quality.

Table One: Success Criteria Summary and Site Applicability

Criteria Category	Success Criteria	Applicable Sites
Physical Success Criteria		
Intertidal Area	Physical Success Criterion 1: The total restored area between an elevation of +12.0 ft. MLLW and -2.0 ft. MLLW will be at least 90% of the target intertidal elevation for each site.	ALL
Tidal Regime	Physical Success Criterion 2: Tidal amplitude, as determined by both timing and elevation of high and low tide events, is equivalent inside and outside of the project area.	Seaboard, Hamm Creek, North Wind's Weir
Slope Erosion	Physical Success Criterion 3: No evidence of erosion that threatens property, infrastructure, or is otherwise unacceptable is observed after a period of initial site stabilization.	ALL
Sediment Structure	Physical Success Criterion 4: Over time, sites will accumulate fine grained material and organic matter. This would be evidenced by a decrease in mean grain size, and an increase in organic carbon, in surface sediments.	ALL
Sediment Quality	Physical Success Criterion 5: No evidence of contamination due to sediment transport or on-site migration of upland contaminants to groundwater or aquatic area.	primarily Seaboard, other sites as needed
Biological Success Criteria		
Marsh Vegetation Establishment	Biological Success Criterion 1: The areal extent (percent cover) of vegetation should be stable or increasing within portions of the project site with elevations suitable to marsh establishment. Biological Success Criterion 2: Species composition of native wetland plant species should be comparable to that of appropriate reference sites, and should not contain greater than 1% cover by area by non-native or invasive plant species. Biological Success Criterion 3: Plant vigor, as measured by stem height and shoot density, should be comparable (greater than 80%) to that of appropriate reference sites and/or improving over time.	ALL

Criteria Category	Success Criteria	Applicable Sites
Riparian Vegetation Establishment	Biological Success Criterion 4: Areal extent of riparian vegetation (native trees and shrubs) should be stable or increasing over time, and cover not less than 90% of the upland vegetated area of each project site at the end of ten years. Invasive plant coverage should be minimal. [see Table associated with this criterion for % cover objectives for vegetation layers] Biological Success Criterion 5: Survival of riparian plantings in each cover class category (herb, shrub, trees) should be at least 75% at the end of three years.	ALL
Bird Use	Biological Success Criterion 6: Use of the restoration sites and the area within 50 meters of the site by indigenous/native bird species should be comparable of that to appropriate reference sites.	ALL; projects will be sampled as part of 2 geographic areas – Kellogg Island or Turning Basin
Fish Access/Presence	Biological Success Criterion 7: Estuarine fish will access the project sites. Juvenile salmonid presence within the project sites should be comparable to that of appropriate reference sites at the end of ten years.	ALL
Invertebrate Prey Resource Production	Biological Success Criterion 8: Production of invertebrate prey taxa known to be important to juvenile salmonids should be comparable to that of appropriate reference sites at the end of ten years.	ALL

Monitoring Program Management

Monitoring Program Responsibility

By Panel resolution, the USFWS has been given the overall responsibility for implementing this monitoring program. The responsibility includes the design and implementation of monitoring tasks, data management, preparation of monitoring reports, and distribution of products. Also by resolution of the EB/DRP Panel, funds necessary to cover the anticipated costs of monitoring program implementation will be transferred from the court registry account to the Department of the Interior NRDA Restoration Fund. The design and implementation activities are considered separate from the role of USFWS as a Panel member in its capacity as a natural resource trustee.

Monitoring Program Implementation

According to schedules provided to EB/DRP from entities responsible for construction of the four intertidal habitat restoration projects covered under this monitoring program, all aspects of project implementation should be complete by the late fall, 2000. It is anticipated that year 1 monitoring tasks will begin in January 2001, and end in December 2001. Similarly, future monitoring years will be equivalent to calendar years (ie. begin in January, end in December). The final year of monitoring is scheduled in post construction year 10, or the year 2010.

To the extent practicable, volunteer stewardship groups and conservation organizations will be used to carry out some of the tasks identified in this monitoring program. This relates in part to controlling monitoring program costs. The greater benefit and motivation, however, rests on the belief that volunteer stewardship and conservation organizations' involvement will foster community support for and stewardship of the completed restoration projects.

USFWS will oversee training of the volunteer monitors and retains responsibility for the quality of the data. Where it is not feasible for reasons of data QA/QC, complexity of the monitoring task(s), or safety, USFWS personnel or their contractors will complete monitoring tasks. If contractors are utilized, USFWS will hold the contractors responsible for data quality control, and will itself retain responsibility for quality assurance through management of contracts and review of draft reports.

Monitoring Program Reports

In each year of substantial monitoring activity (years 1,2,3,5,7,and 10), USFWS will prepare a report which presents a summary and evaluation of the monitoring program results. At a minimum, the report will summarize:

1. Monitoring tasks completed (methods, sampling locations, dates);
2. Data and other monitoring results;
3. Status of project sites;
4. Trends in data, for both individual sites and the overall program;
5. "Red flags" indicating need for consideration of contingency measures;
6. Externalities that may be influencing monitoring results; and
7. Recommendations and alternatives for action.

A draft report will be distributed to Panel members for their review and comment within

three months of the completion of an annual sampling period. When necessary, a meeting of the Panel of Managers will be called to present monitoring program results and discuss the implications, including need for contingency measures. Responsibility for completion of contingency measures identified as necessary by the Panel would rest with the land owner and/or project manager. A final report incorporating Panel member comments and identified contingency measures will be prepared for distribution. Recipients of final reports will include, in addition to Panel members, other interested agencies and permitting authorities, as well as members of the public or other parties who have requested copies of the report.

USFWS will distribute monitoring program results, including responding to requests for copies of the reports, to the fullest extent practicable. In order to facilitate widespread distribution while controlling printing costs, USFWS will explore options for distribution through the internet and other means. Feasible options will be discussed with the Panel.

Scientific Research Activities

The express purpose of this monitoring program is to evaluate progress in achieving EB/DRP goals and objectives. Funds for the habitat development program are limited, and there is much interest in applying as much funding as possible to achieving on the ground results. However, the Panel recognizes its responsibility for project follow through, including monitoring. Necessarily, the monitoring program is therefore limited in scope to addressing the important question of project performance.

The EB/DRP Panel of Managers also recognizes the inherent scientific interest in these projects and activities. There exists some responsibility on the part of the Panel to build the body of knowledge, and to provide future restoration programs with the benefit of the lessons we have learned. The Panel encourages research activities that utilize the monitoring data as background, but are beyond the scope of this program. Towards this end, EB/DRP will make available all monitoring program data and provide other support where feasible. Land owners of habitat sites will be encouraged to accommodate scientific research activities, where these activities do not interfere with the habitat objectives of EB/DRP. Finally, efforts will be made to provide scientific presentations of project results to relevant professional society organizations, and/or publications in peer-reviewed scientific journals.

Modifications of the Monitoring Program

An important purpose of this report is to "institutionalize" an approach to project monitoring as agreed upon by the EB/DRP Panel. Given the long-term nature (10 years post-construction) of the monitoring program, it is important to provide a clear description of the program. It is also important to maintain a continuous data series that allows for inter-site and inter-annual comparisons. In addition to the need for long-term monitoring program consistency, it is also important to recognize a potential need to modify the program.

At least three types of changes to the monitoring program can be envisioned at this point.

1. Changes in monitoring tasks. Over the five year period of monitoring restoration projects completed under the Coastal America program, improvements in field and laboratory techniques have led to changes in monitoring task protocols

(Cordell et al. 1994, 1996, 1997, 1999). While the current monitoring program builds on this experience, it is likely that other opportunities for improvement will be identified which should be incorporated into the monitoring program.

2. Elimination of monitoring tasks. It is possible that in the future, the EB/DRP Panel might reach consensus that specific success criteria have been met, and that associated monitoring tasks could cease. Similarly, it could be determined that a monitoring task was not returning useful information, and therefore not worth the expense of continuation.

3. Modification of project objectives. In describing the application of adaptive management principles to coastal restoration projects, Thom (1997) suggests that modifying project objectives during the monitoring period is a reasonable alternative. Unrealistic expectations or inaccurate assumptions can lead to establishment of inappropriate project objectives. While considerable effort has gone into the development of success criteria for the EB/DRP monitoring program, it is possible that a decision to modify might be reached based on program results.

Therefore, it is acknowledged that it is necessary to strike a balance between a monitoring program that provides long-term consistency and comparability and real-word practicability. The potential need to modify this program in the future is recognized by the EB/DRP Panel.

Monitoring Program Budget

The budget presented in Table Two provides costs for activities conducted pursuant to physical and biological success criteria and monitoring tasks and report preparation and distribution as discussed in the Monitoring Program. Costs are identified for personnel and supplies by the year, beginning with year 1 of the monitoring program and ending in year 10. The budget assumes a 3% inflation rate. A detailed estimation of resources (personnel, materials) required for each task is presented in Appendix B.

The total estimated cost of monitoring activities identified for the four intertidal habitat restoration projects undertaken by the Panel is $699,720. Figure One shows a breakdown of monitoring program costs by category. The estimated upper limit on USFWS Regional Office administrative costs (ie. overhead) is $21,497, bringing the estimated project total to $721,217.

It should be noted that if annual increases in inflation as high as 8% occur total, estimated costs for implementing the full monitoring program would be. While interest that is anticipated to accrue on monitoring program funds is projected to cover this potential increase in project costs, procedures for managing budget shortfalls (and surplus) will need to be worked out between USFWS and the EB/DRP Panel.

Table Two: EB/DRP Intertidal Habitat Projects Monitoring Program Budget

Criteria	Task	Biodays /site	Techdays /site	# sites	total personnel	materials /supplies	total 1st year	total year 2	total year 3	total year 5	total year 7	total year 10	subtask total
Intertidal Area													
	establish +12 ft. benchmark	1.00	1.00	4.0	$3,048	$50	$3,098	$0	$0	$0	$0	$0	
	select +12 or greater tide event when water reaches benchmark												
	map perimeter of water edge w/ GPS		0.50	4.0	$508		$508	$523	$539	$572	$607	$663	
	prepare map, calculate intertidal area		0.50	4.0	$508		$508	$523	$539	$572	$607	$663	
	establish permanent transects note topo & habitat breakpoints	1.00	1.00	4.0	$3,048		$3,048	$0	$0	$0	$0	$0	
	acquire x-section elev. data		1.00	4.0	$1,016		$1,016	$1,046	$1,078	$1,144	$1,213	$1,326	
	acquire low tide aerial photos					$2,500	$2,500	$2,575	$2,652	$2,814	$2,985	$3,262	
	digitize, geo-reference, import to GIS	0.50		4.0	$1,016		$1,016	$1,046	$1,078	$1,144	$1,213	$1,326	
	overlay GPS & x-section data		1.00	4.0	$1,016		$1,016	$1,046	$1,078	$1,144	$1,213	$1,326	
	TASK SUBTOTAL						*$12,710*	*$6,761*	*$6,964*	*$7,388*	*$7,838*	*$8,565*	***$50,225***
Tidal Regime													
	acquire tide gauges		0.33	3.0	$254	$2,550	$2,804	$0	$0	$0	$0	$0	
	install and survey	0.50	0.50	3.0	$1,143	$0	$1,143	$0	$0	$1,286	$0	$0	
	download monthly		4.00	3.0	$3,048	$0	$3,048	$3,139	$0	$3,331	$0	$0	
	TASK SUBTOTAL						*$6,995*	*$3,139*	*$0*	*$4,617*	*$0*	*$0*	***$14,752***
Slope erosion/accretion													
	establish photopoints	0.25	0.25	4.0	$762		$762	$0	$0	$0	$0	$0	
	monitor quarterly		1.00	4.0	$1,016	$100	$1,116	$1,149	$1,184	$1,256	$1,333	$1,456	
	TASK SUBTOTAL						*$1,878*	*$1,149*	*$1,184*	*$1,256*	*$1,333*	*$1,456*	***$8,256***
Sediment structure													
	collect 10 cores @ site		0.50	4.0	$508		$508	$523	$539	$572	$607	$663	
	upper (>+10) and lower (<+9)						$0						
	analyze grain size		1.00	4.0	$1,016	$400	$1,416	$1,046	$1,078	$1,144	$1,213	$1,326	
	analyze organic content		1.00	4.0	$1,016		$1,016	$1,046	$1,078	$1,144	$1,213	$1,326	
	TASK SUBTOTAL						*$2,940*	*$2,616*	*$2,695*	*$2,859*	*$3,033*	*$3,314*	***$17,457***

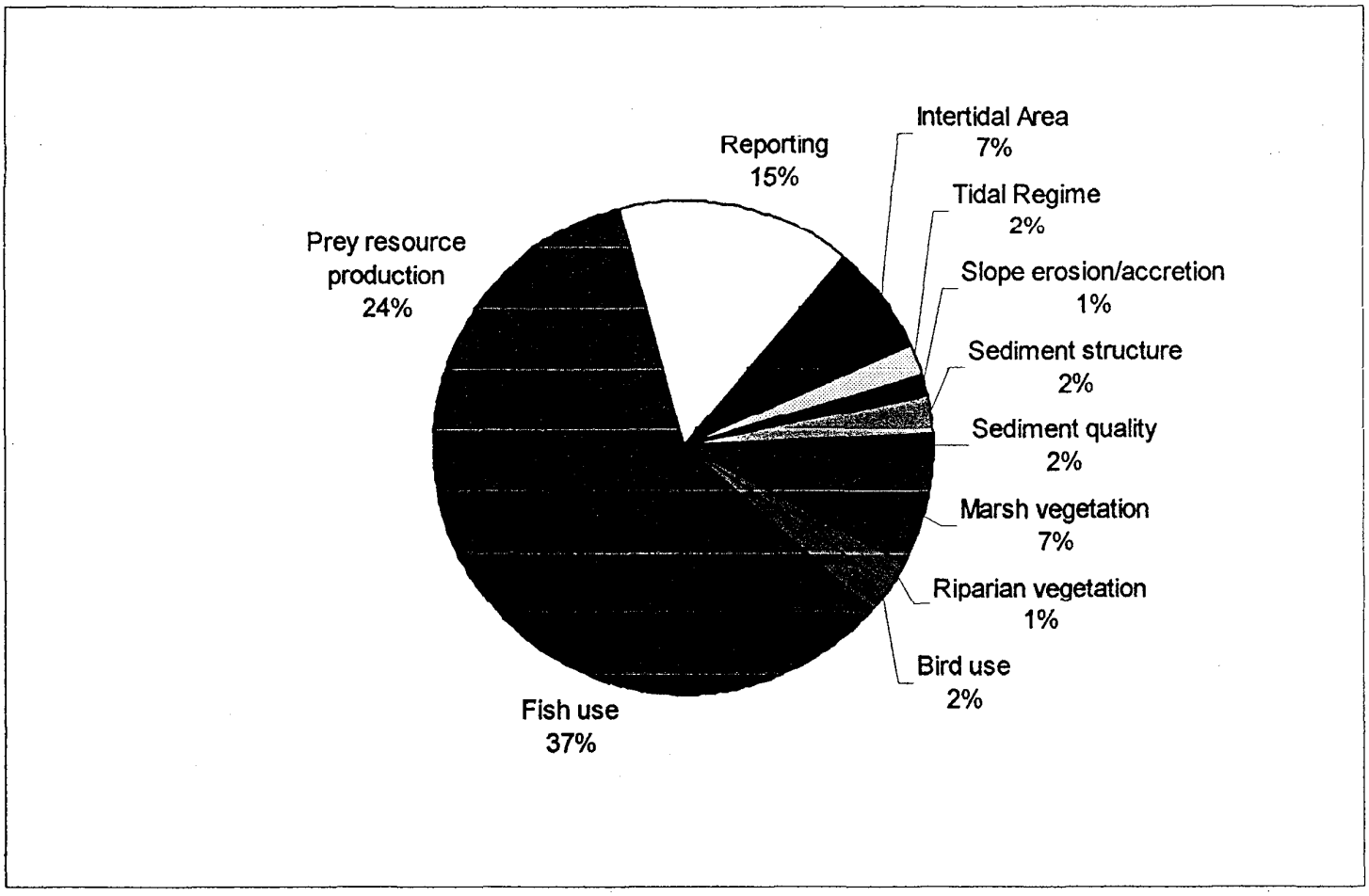
Criteria	Task	Biodays /site	Techdays /site	# sites	total personnel	materials /supplies	total 1st year	total year 2	total year 3	total year 5	total year 7	total year 10	subtask total
Sediment quality													
	Install groundwater monitoring wells					$6,500	$6,500	$0	$0	$0	$0	$0	
	Groundwater sampling and analysis					$6,500	$6,500	$0	$0	$0	$0	$0	
	Well closure					$1,000	$1,000	$0	$0	$0	$0	$0	
	TASK SUBTOTAL						*$14,000*	*$0*	*$0*	*$0*	*$0*	*$0*	***$14,000***
Marsh vegetation													
	use aerial photos												
	delineate marsh veg. cover	0.50	1.50	4.0	$2,540		$2,540	$2,616	$2,695	$2,859	$3,033	$3,314	
	OR												
	use GPS												
	delineate marsh veg. cover												
	use permanent transects												
	sample w/ quadrats												
	ID plant spp.												
	est. % cover	0.50	0.50	6.0	$2,286		$2,286	$2,355	$2,425	$2,573	$2,730	$2,983	
	measure stem height	0.25	0.25	6.0	$1,143		$1,143	$1,177	$1,213	$1,286	$1,365	$1,491	
	measure shoot density	0.25	0.25	6.0	$1,143		$1,143	$1,177	$1,213	$1,286	$1,365	$1,491	
	TASK SUBTOTAL						*$7,112*	*$7,325*	*$7,545*	*$8,005*	*$8,492*	*$9,280*	***$47,759***
Riparian vegetation													
	use aerial photos												
	delineate riparian veg. cover		0.50	4.0	$508		$508	$523	$539	$572	$607	$663	
	OR												
	use GPS												
	delineate riparian veg. cover												
	use permanent transect												
	est. % survival along transect	0.25	0.50	4.0	$1,016		$1,016	$1,046	$1,078	$1,144	$1,213	$1,326	
	TASK SUBTOTAL						*$1,524*	*$1,570*	*$1,617*	*$1,715*	*$1,820*	*$1,988*	***$10,234***
Bird use													
	establish observation points	0.50	0.50	2.0	$762		$762	$0	$0	$0	$0	$0	
	monitor quarterly		4.00	2.0	$2,032		$2,032	$2,093	$2,156	$2,287	$2,426	$2,651	
	TASK SUBTOTAL						*$2,794*	*$2,093*	*$2,156*	*$2,287*	*$2,426*	*$2,651*	***$14,407***

Criteria	Task	Biodays /site	Techdays /site	# sites	total personnel	materials /supplies	total 1st year	total year 2	total year 3	total year 5	total year 7	total year 10	subtask total
Fish use													
	determine sample methods	1.00	1.00	4.0	$3,048		$3,048						
	sample for fish access												
	deploy block nets					$3,000	$3,000	$0	$0	$0	$0	$0	
	2x/mo. 1 Mar - 15 June												
	id, measure, release	8.00	8.00	6.0	$36,576		$36,576	$37,673	$38,803	$41,167	$43,674	$47,723	
	TASK SUBTOTAL						*$42,624*	*$37,673*	*$38,803*	*$41,167*	*$43,674*	*$47,723*	***$251,664***
Prey resource production													
	sample fallout insects												
	deploy float traps					$200	$200	$0	$0	$0	$0	$0	
	1x/mo. 1 Mar - 15 June	1.00	2.00	6.0	$6,096		$6,096	$6,279	$6,467	$6,861	$7,279	$7,954	
	id, enumerate		4.00	6.0	$6,096		$6,096	$6,279	$6,467	$6,861	$7,279	$7,954	
	sample benthic inverts					$200	$200	$0	$0	$0	$0	$0	
	collect core samples	1.00	2.00	6.0	$6,096		$6,096	$6,279	$6,467	$6,861	$7,279	$7,954	
	1x/mo. 1 Mar - 15 June												
	id, enumerate		4.00	6.0	$6,096		$6,096	$6,279	$6,467	$6,861	$7,279	$7,954	
	TASK SUBTOTAL						*$24,784*	*$25,116*	*$25,869*	*$27,444*	*$29,116*	*$31,816*	***$164,144***
Reporting													
	Data preparation	10.00	20.00	1.0	$10,160		$10,160	$10,465	$10,779	$11,435	$12,132	$13,256	
	Report preparation	10.00	10.00	1.0	$7,620		$7,620	$3,924	$4,042	$4,288	$4,549	$4,971	
	Printing & distribution		5.00	1.0	$1,270	$100	$1,370	$1,411	$1,453	$1,542	$1,636	$1,788	
	TASK SUBTOTAL						*$19,150*	*$15,800*	*$16,274*	*$17,265*	*$18,317*	*$20,015*	***$106,822***
PROJECT EXPENSES (assumes 3% inflation rate)							**$136,511**	**$103,243**	**$103,107**	**$114,003**	**$116,048**	**$126,808**	***$699,720***
REGIONAL OFFICE OVERHEAD							$ 11,826	$4,168	$1,935	$1,140	$1,160	$1,268	***$21,497***
PROJECT TOTAL							**$148,337**	**$107,411**	**$105,042**	**$115,143**	**$117,208**	**$128,076**	***$721,217***

NOTE: The following figures are to demonstrate the effect of inflation rate on project expenses.

PROJECT EXPENSES (assumes 8% inflation rate)	**$108,255**	**$113,360**	**$137,618**	**$154,225**	**$194,279**	***$844,248***

Figure One: Breakdown of Monitoring Program Budget by Category



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Appendix A: Project Descriptions

Seaboard Lumber Aquatic Habitat Restoration Project

Site Location

The habitat project is on the site of the former Seaboard Lumber Mill that operated until the 1980's, on the west shore of the Duwamish River at river mile 2. The project is in the vicinity of Kellogg Island, the last natural oxbow of the Duwamish Waterway, the adjacent Terminal 107 restoration and park area, and the Duwamish greenbelt. The site is comprised of approximately 5.7 acres of upland and 11 acres of intertidal and subtidal areas.

Condition Prior to Habitat Restoration Project

Historically, the upland site was a marsh/channel of the Duwamish River. The site has a history of diverse industrial uses. Site investigations identified various fill materials, contaminated fill, dredge waste sand and silt, and debris, including concrete, asphalt blocks, and metal debris. The site included a storm drain easement owned by Holland America, on the upland portion of the adjacent upland parcel, and only minor areas of vegetative cover comprised of invasive species and no trees. Approximately 248 creosoted wooden pilings were located in the submerged area of the site.

Site Preparation

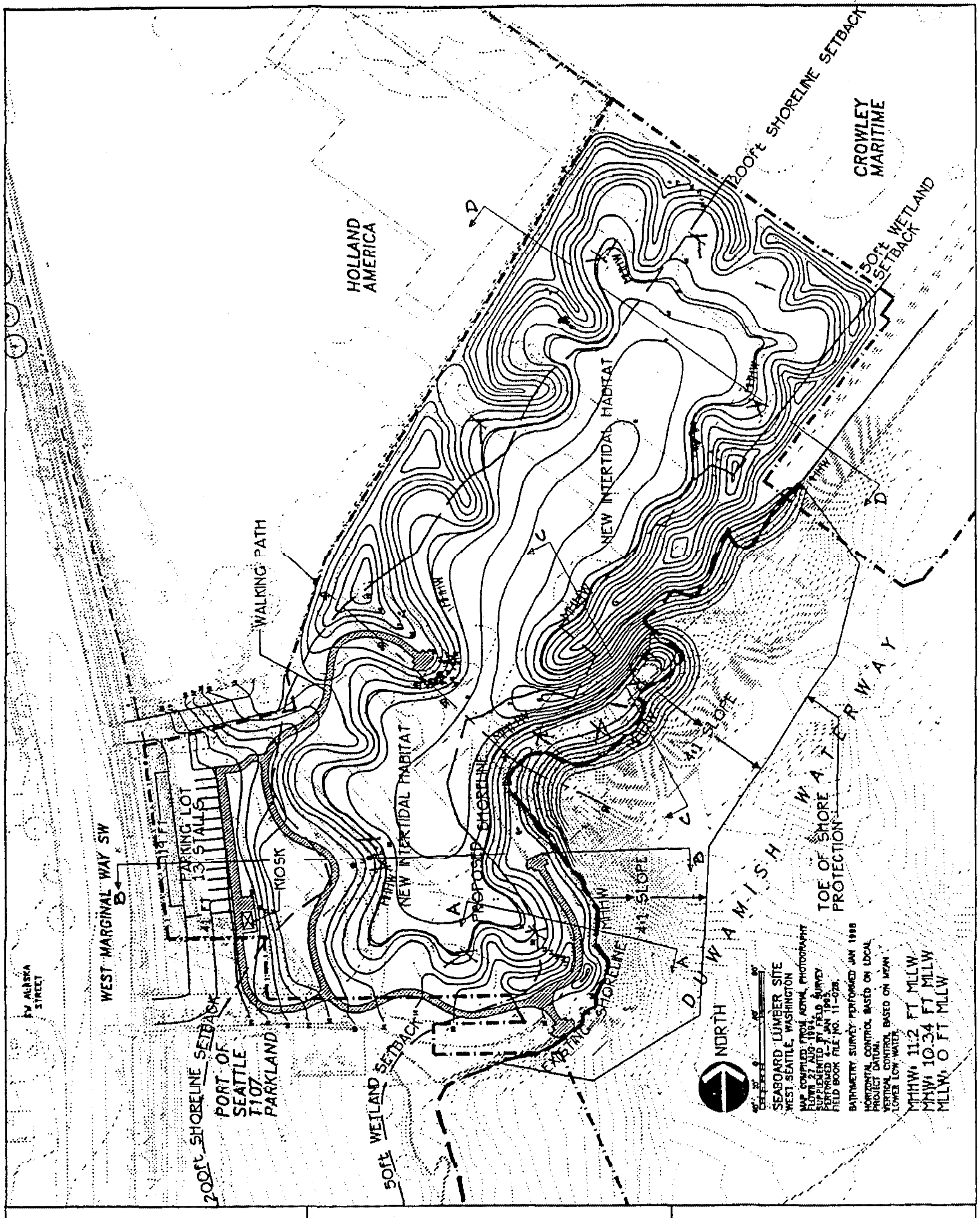
Activities completed to insure suitability of the site for habitat development included the demolition of former structures associated with the mill operation; removal of a 9200 sq. ft. shoreline dock structure, including the supporting piles, decking hardware, concrete foundations, areas of paving and partially buried railroad spurs; and removal and disposal of soils with concentrations of TPH, lead, mercury, and polycyclic aromatic hydrocarbons (PAHs) that exceed the Washington State Model Toxics Control Act Cleanup criteria. A cultural resources assessment was conducted.

Project Design and Implementation

Activities included the excavation of a 1.8 acre intertidal bay designed with a curvilinear edge to elevations between +6 to +12 feet MLLW protected by two armored spits forming a mouth opening to the Duwamish River; distribution of an amended on-site soil mixture of silts and clays with high organic content to a depth of 18 inches over the basin; planting of slopes of the intertidal area with various emergent marsh plants at various elevations and the introduction of transitional scrub/shrub habitat between the intertidal marsh, upland meadow and forested habitat.

Habitat Project Goals

Objectives for the site include the following: Maximizing intertidal habitat, creating a low wave energy environment, providing a perimeter buffer of upland vegetation, removing and containing site contaminants, and protecting the Duwamish River from exposure to on-site soils at the shoreline that contain residual concentrations of chemicals. Secondary objectives include opportunities for passive recreational use and environmental education.



PROPOSED: INTERTIDAL MARSH CREATION WITH VIEWPOINTS IN: CITY OF SEATTLE AT: SEABOARD LUMBER SITE COUNTY OF: KING STATE: WA APPL. BY: SEATTLE PARKS + RECREATION DATE: JANUARY 30, 1998 FIGURE: 4 OF 12	CITY OF SEATTLE DEPARTMENT OF PARKS AND RECREATION 2911 SECOND AVE. 4th FLOOR (684-7931) FACILITY TITLE SEABOARD LUMBER AQUATIC HABITAT RESTORATION	PURPOSE: FISHERIES HABITAT ENHANCEMENT, PUBLIC VIEWING + EDUCATION DATUM: MLLW=0.0 (N.O.S.) ADJ. WATERFRONT PROPERTY OWNERS: HOLLAND AMERICA, PORT OF SEATTLE, + CROWLEY MARITIME PREPARED BY: **Lee/Brennan Associates** **E C G International Inc.**

Seaboard Lumber Site Plan

Hamm Creek Aquatic Habitat Restoration Project

Site Location

The restoration site is an irregularly shaped 6.2 acre parcel of land in the general area known as the Turning Basin Number 3, near River mile 6 on the west bank of the Duwamish River. It is within a 21.5 acre area of grassy field bounded to the south by Seattle City Light's Duwamish substation, to the north by Delta Marine Industries facilities, to the east by the Duwamish Waterway, and to the west by West Marginal Way South and Highway 99. Hamm Creek, confined to an open ditch, runs along the west boundary of the property.

Condition Prior to Habitat Restoration Project

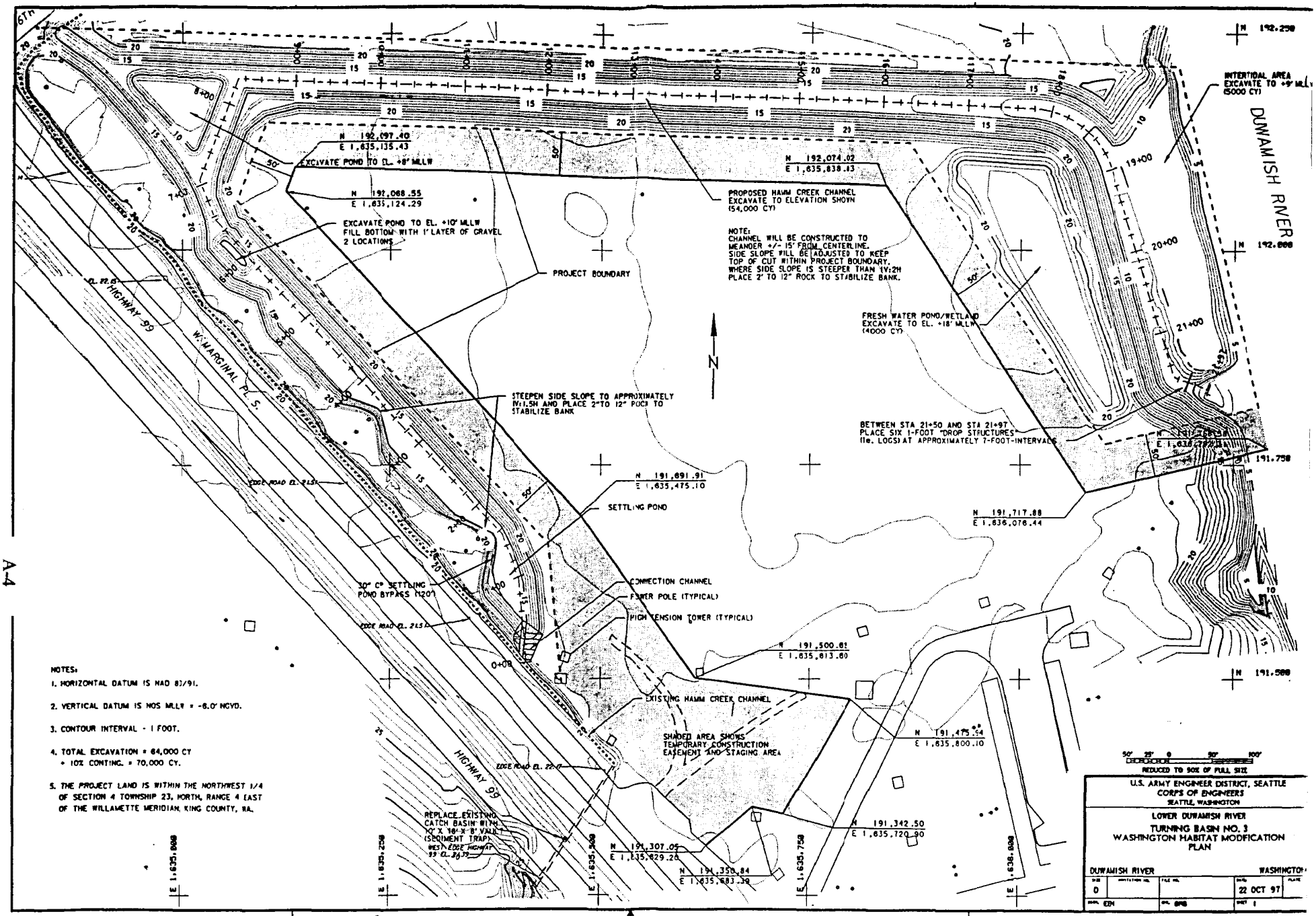
Historically, Hamm Creek meandered through an intertidal marsh within the project as it made its way to the Duwamish River. From the early 1950's through 1971, the site was used as a dredged material stockpiling area. Consequently, Hamm Creek was "placed" in a ditch and routed into a culvert with an outfall into the Duwamish River accessible to fish only at higher tides.

Project Implementation Activities

Together with the Army Corps of Engineers under Section 1135 funding, King County DNR is creating 1,900 feet of new productive riparian stream bed and channel for Hamm Creek which borders the northern and eastern portions of the site. Design features of the more natural channel includes meanders, fish pools and large woody debris. Native trees and shrubs forming a riparian buffer are to be planted on the upper slopes of the bank. The Panel contributed to the purchase of real property, design, construction, and monitoring of one acre of estuarine marsh to be created on the east side of the creek in the vicinity of the connection to the river.

Habitat Project Goals

Objectives for the site include a combination of freshwater and tidal wetland restoration as well as stream and riparian corridor improvements for the lower reach of Hamm Creek.



Hamm Creek Site Plan

Turning Basin No. 3 Aquatic Habitat Restoration Project

Site Location

The project site is located on the former Kenco Marine Services (Kenco) property at the western upstream boundary of the maintained navigation channel at Turning Basin No. 3 of the Duwamish River. The .82 acre parcel is bordered on the western edge by West Marginal Way South. City Light Duwamish Substation property is to the North, and Coastal America and Port of Seattle mitigation projects are to the south of the parcel. The .82 acre parcel includes uplands and intertidal mudflats.

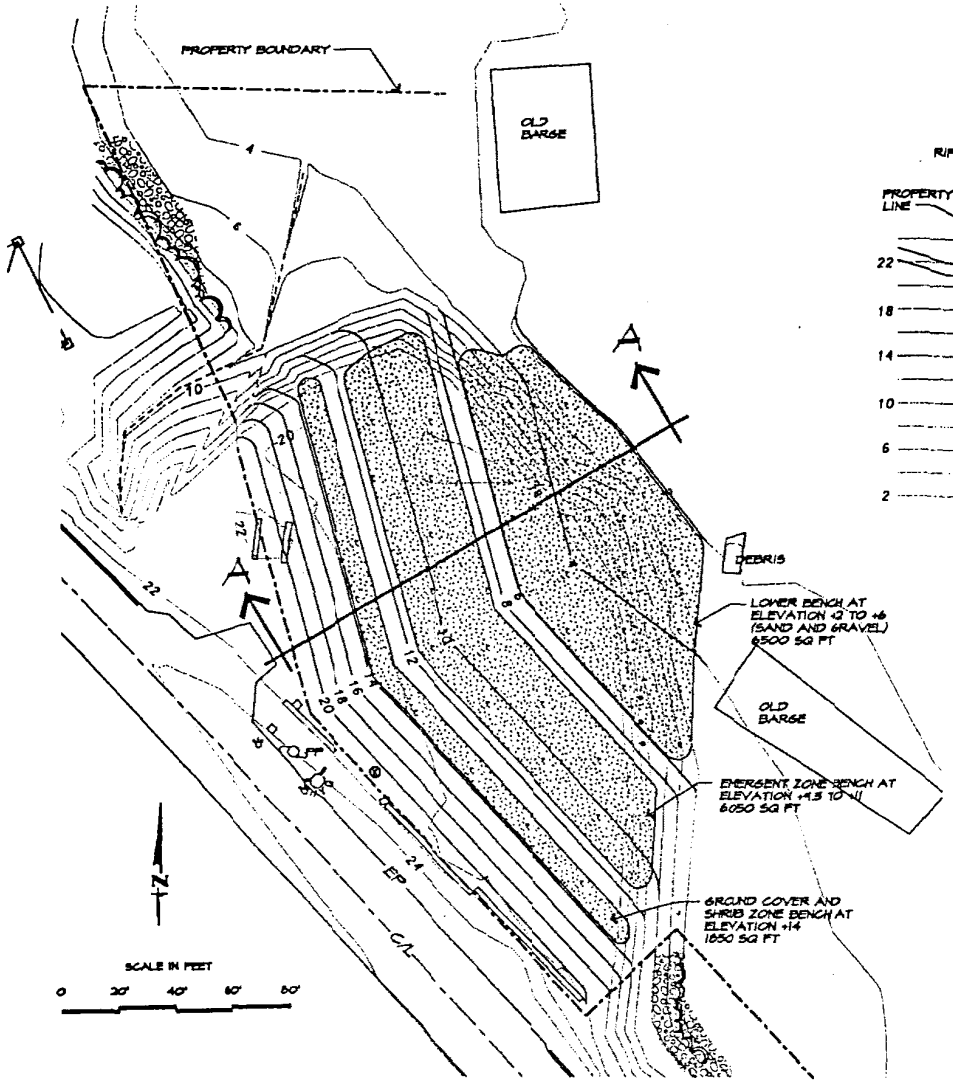
Condition Prior to Restoration Project

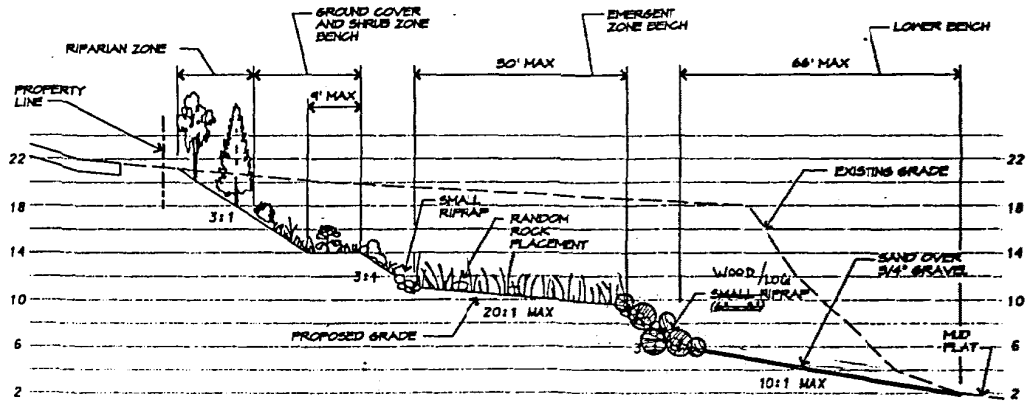
The upland portion of the site is at an elevation of +15 feet and is primarily a peninsula composed of fill material, with a commercial pier extending approximately 125' into the Turning Basin. The upland area is covered with asphalt and concrete pads, in addition to an office/warehouse structure, small storage sheds, and a house. The property is steep sloped. Prior to purchase, barges and other vessels were moored in the intertidal and subtidal area. Project implementation activities include removing existing commercial structures and recontouring and revegetation the area to provide an enhanced intertidal estuarine wetland area. "Benches" will be created at various elevations. A "lower bench" at elevation +2 to +6 feet, at a 10:1 slope of sand over 3/4" gravel substrate will create 6,500 sq. ft. of habitat. "Soft" substrates (wood) will be used at the transition to the emergent zone bench. An "emergent zone bench" at elevation +9.5 to +11 feet, at a 20:1 slope planted with native intertidal vegetation and random rock placement will create 6,050 sq. ft. of habitat. A "groundcover and shrub zone bench" at elevation +14 to +17 feet, at a 3:1 slope planted with native riparian vegetation will create 1,850 sq. ft. of habitat. Upon purchase of the property, the removal and prohibition against moorage of barges and other vessels exposed 16,000 - 18,000 sq. ft. of intertidal and subtidal mudflats.

Habitat Project Goals

Objectives for the site include significant gains in intertidal and subtidal mudflats through prohibitions of moorage and an enhanced intertidal estuarine wetland area through the creation of benches.

TURNING BASIN #3 RESTORATION
SITE PLAN - OPTION 1





SECTION AA

VERTICAL SCALE IN FEET (APPROXIMATE)
0 5' 10' 15' 20'

HORIZONTAL SCALE IN FEET (APPROXIMATE)
0 10' 20' 30' 40'

FISHPRO

A-6

Turning Basin No. 3 Site Plan

North Wind's Weir Aquatic Habitat Restoration Project

Site Location

North Wind's Weir is on 3.1 acres of land south of the Duwamish Waterway Turning Basin No. 3, upstream of the navigable waterway on the west bank of the Duwamish River at approximately river mile 7. Panel funds were used to purchase a 1.03 acre parcel of the property to conduct habitat restoration activities.

Condition Prior to Habitat Restoration Project

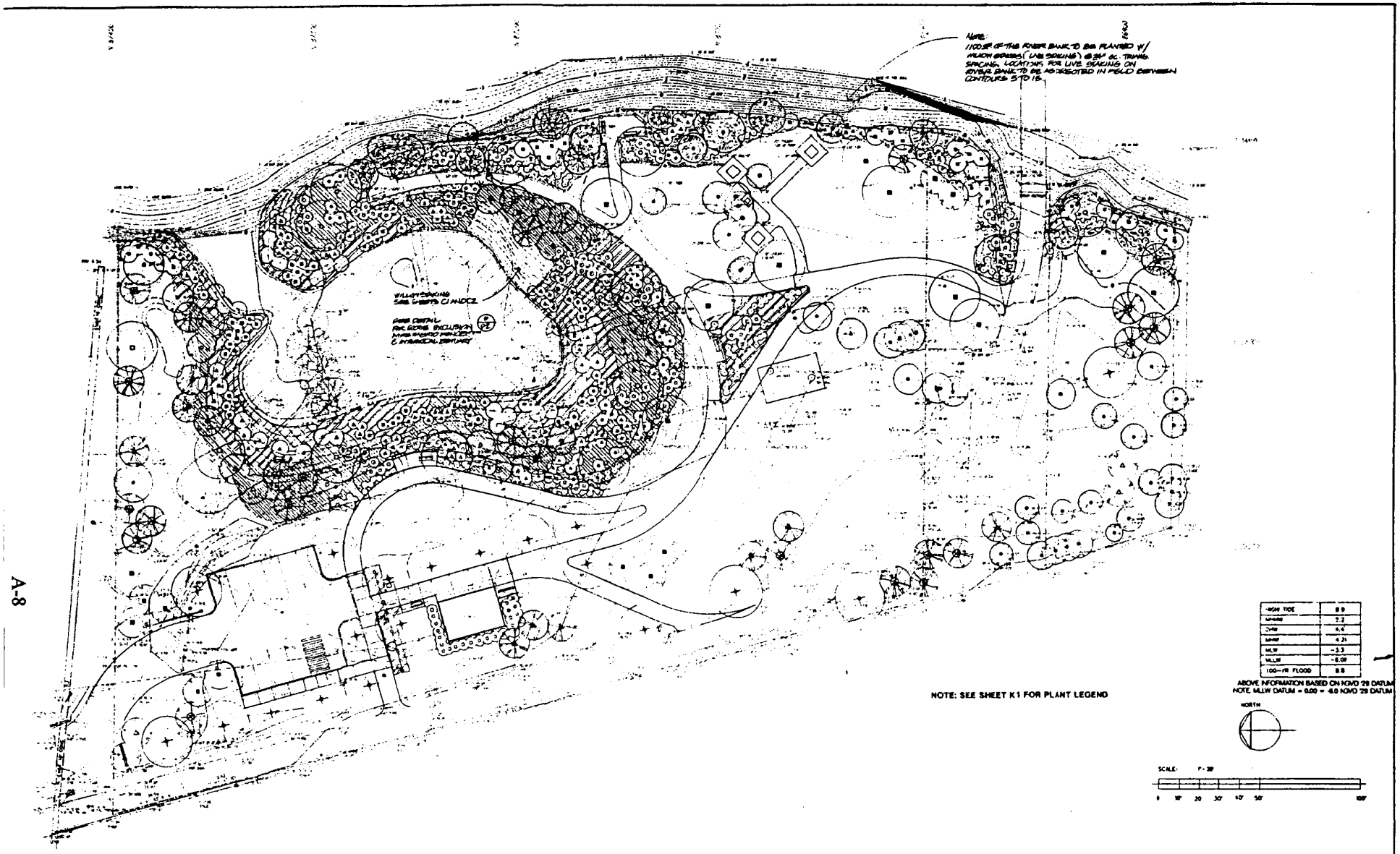
Converted from natural area to "improved industrial land,"the site was developed in the 1930's and 1940's for single family residential housing. Residential structures were subsequently removed from the site. A step bank along the river right-of-way slopes downward (almost vertical) approximately 20 feet to the riverbed. The shoreline is riprap in the lower intertidal to subtidal areas. Coniferous and deciduous trees and shrubs are on the upland portion of the property.

Project Implementation Activities

The Panel's intertidal habitat project will be complemented by upland improvements to be undertaken by King County, including trails, shoreline stabilization, plantings, and interpretive features highlighting the cultural significance of the site to Native Americans. A cultural resource assessment was undertaken in 1996. A 1.03 acre intertidal basin is scheduled for construction in the year 2000. The intertidal habitat will be excavated from an elevation of +6 to +15 feet MLLW. It is designed with a curvilinear edge to create a more natural appearance and to maximize habitat diversity at the edge zone. Connection to the Duwamish River will be at the northeast end of the property, achieved by using natural bank slopes stabilized with vegetation. The "softer" engineering approach will allow a more natural stabilization process to occur at the site. Upland edges are to be revegetated with native trees and shrubs to form a riparian buffer designed to incorporate as many mature coniferous trees and native shrubs present on the site as possible.

Habitat Project Goals

The new intertidal habitat will assist migrating salmonids to acclimate on their downstream passage, stabilize the shoreline, and improve riparian conditions. Secondary objectives of King County's upland work include opportunities for passive park use, bicycle trail access, and environmental education.



CLIENT AGENCY:
KING COUNTY
DEPARTMENT OF PARKS, CULTURAL AND NATURAL RESOURCES
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SEATTLE, WA 98104

KING COUNTY
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Seattle, Washington 98104
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MacLeod Reckord
Landscape Architects

NORTH WIND'S WEIR PARK

PLANTING PLAN

L5

A-8

North Wind's Weir Site Plan

Appendix B: Estimation of Resources Required for Monitoring Plan Implementation

Intertidal Area

Approach

1. Use GPS to map +12'MLLW contour at each project site.
2. Use physical survey methods (laser level) to generate cross section profiles, preferably along same permanent transect lines used to evaluate vegetation.
3. Acquire digital aerial photographs of project sites and incorporate into GIS database.
4. Create GIS data layer from contour and cross section data.

Resources Required

Initial

1. 1 Biologist-day (engineer) and 1 Technician-day per site to establish +12 benchmark.
2. 1 Biologist-day and 1 Technician-day per site to establish permanent transect locations for each site.

On-going

1. 0.5 Technician-day per site to acquire GPS data (+12' wetted area perimeter).
2. 0.5 Technician-day x 2 per site to acquire cross section data
3. 1.0 Technician-day per site to download GPS and survey data, incorporate into GIS.
4. Acquire low tide digital aerial photos (contract; $2500/event year)
5. 2.0 Biologist-day (GIS specialist) per event year to upload aerial photo data and assist with georeferencing
6. 2.0 Technician-day per event year to create maps from GIS data

Tidal Regime

Approach

1. Acquire and install continuous recording, pressure transducer type water level loggers
2. Download water level data on a monthly basis

Resources Required

Initial

1. Purchase water level loggers for enclosed basin type restoration sites (3 @ $795)
2. 0.5 Biologist-day (engineer) and 0.5 Technician-day per site to install and survey elevation of water level logger

On-going

1. 1.0 Biologist-day per month to download data from all three water level loggers

Slope Erosion

Approach

1. Establish one or more appropriate photo point locations at each site for evaluating slope erosion
2. Conduct quarterly visual inspections of sites for evidence of slope erosion, and photograph site from established photo point(s)
3. Increase frequency of observations, if possible, with use of volunteers

Resources Required

Initial

1. 1 Biologist-day and 1 Technician-day to establish photo point locations at all four restoration project sites

On-going

1. 1 Technician-day per quarter to complete inspection and photography at all four sites
2. Photographic supplies; $100 per event year

Sediment Structure

Approach

1. Collect six sediment cores (3 each within two different sampling areas) at each site in areas where epibenthic invertebrate are sampled.
2. Using nested sieves, analyze sediment samples in lab for sediment grain size.
3. Using standard methods, analyze sediment samples in lab for organic content.

Resources Required

Initial

none

On-going

1. 0.5 Technician-day per site to collect sediment samples
2. 1.0 Technician-day per site to complete grain size analysis
3. 1.0 Technician-day per site to complete organic content analysis

Sediment Quality

Initial

1. Install two groundwater wells at Seaboard Lumber site – $6500
2. Groundwater sampling once per quarter for one year – $6500
3. Well closure; pull casings and fill holes with bentonite – $1000

On-going

none

Marsh Vegetation

Approach

1. Identify specific sampling locations at each of four project and two reference sites.
2. Using digital aerial photos or GPS methods, delineate areas of marsh vegetation cover
3. Using permanent transects and quadrat sampling methods, assess areas of intertidal vegetation for:
   a. Species present
   b. % cover by species
   c. Stem height
   d. Shoot density

Resources Required

Initial

none - transects previously established under "intertidal area" tasks

On-going

4. 0.5 Biologist-day and 1.5 Technician-day per site to delineate extent of vegetated area
5. 1 Technician-day and 1 Biologist-day per site to complete transect data collection

Riparian Vegetation

Approach

4. Using digital aerial photos or GPS methods, delineate areas of riparian vegetation cover
5. Using permanent transects, assess percent survival of plantings, and percent cover for:
   a. Herbaceous layer
   b. Shrub layer
   c. Tree layer
   d. Non-native species

Resources Required

Initial

none - transects previously established under "intertidal area" tasks

On-going

1. 0.5 Technician-day per site to delineate extent of riparian vegetation cover
2. 0.25 Biologist-day and 0.5 Technician-day per site to complete transect data collection activities

Bird Use

Approach

1. Establish observation points or routes in 2 larger project areas
2. Monitor bird use within the two areas on a quarterly basis, one morning and one evening each per area per quarter. Note species observed and category of behavior
3. Increase frequency of observations, if possible, with use of volunteers

Resources Required

Initial

1. 1 Biologist-day and 1Technician-day to establish observation areas

On-going

1. 2 Technician-day per quarter to monitor bird use (one @ AM & PM session in two areas)

Fish Access

Approach

1. Identify specific sampling locations at each of four project and two reference sites.
2. Sample each site once every two weeks during the period of juvenile salmonid sample outmigration (1 March to 15 June) using block and/or beach seine methods
3. Identify and count fish captured
4. Collect fork length data on subsample of juvenile salmonids (apx. 25 individuals/spp/sample event)
5. Consider using non-lethal methods to collect stomach contents for diet studies
6. Release all fish unharmed

Resources Required

Initial

1. 1.0 Biologist-day and 1.0 Technician-day per site to determine sampling gear and methods

On-going

1. 1.0 Biologist-day and 1.0 Technician-day per site x 8 sampling events per sampling year

Prey Resources Production

Approach

1. Identify specific sampling locations at each of four project and two reference sites.

2. Using floating traps, collect "fallout insects" monthly during the period of juvenile salmonid sample outmigration (1 March to 15 June)
3. Using core sample techniques, collect benthic invertebrates monthly during the period of juvenile salmonid sample outmigration (1 March to 15 June)

4. In the laboratory, identify invertebrates to lowest taxonomic group possible (use previous Duwamish monitoring studies as guide)

Resources Required

Initial

1. 1.0 Biologist-day and 1.0 Technician-day per site to determine sampling locations

On-going

1. 1.0 Technician-day per site per month to collect both fallout and benthic invertebrate samples
2. 16 Technician-day per event year to analyze fallout insect samples
3. 16 Technician-day per event year to analyze benthic invertebrate samples

Reporting

Resources Required

1. 10 Biologist-day and 20 Technician-day per event year for data entry and analysis
2. 10 Biologist-day and 10 Technician-day per event year for report preparation
3. 5 Technician-day per event year for report revision and distribution